Water Management Plan

Revision 1

U.S. Environmental Protection Agency
National Vehicle and Fuel Emissions Laboratory
2565 Plymouth Road
Ann Arbor, Michigan 48195

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U.S. Environmental Protection Agency
National Vehicle and Fuel Emissions Laboratory

Water Management Plan

Approved by:

Steven V. Dorer, Facility Manager — 6/10/2010
Date

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Date

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1.0 EPA'S STATEMENT OF PRINCIPLES ON EFFICIENT WATER USE

To meet the needs of existing and future populations and ensure that habitats and ecosystems are protected, the nation's water resources must be sustainable and renewable. Sound water resource management, which emphasizes wise, efficient use of water, is essential to achieve these objectives.

Efficient water use can have major environmental, public health, and economic benefits by helping to improve water quality, maintain aquatic ecosystems, and protect drinking water resources. As the country faces increasing risks to ecosystems and their biological integrity, the inextricable link between water quality and water quantity becomes more important. Water efficiency is one way of addressing water quality and quantity goals. The efficient use of water can prevent pollution by reducing wastewater flows, recycling process water, reclaiming wastewater, and using less energy. As municipalities and regions deal with chronic drinking water shortages due to drought and changes in climate patterns, water conservation becomes even more important to EPA's mission.

EPA recognizes that regional, state, and local differences exist regarding water quality, quantity, and use. Differences in climate, geography, and local requirements influence the water efficiency programs applicable to specific facilities. Therefore, EPA is establishing facility-specific Water Management Plans to promote the efficient use of water and meet the water conservation requirements under Executive Order (EO) 13423, *Strengthening Federal Environmental, Energy, and Transportation Management,* and EO 13514, *Federal Leadership in Environmental, Energy, and Economic Performance.*

This Water Management Plan has been established to document and promote the efficient use of water at EPA's National Vehicle and Fuel Emissions Laboratory (NVFEL) located in Ann Arbor, Michigan. The plan is organized according to the Federal Energy Management Program (FEMP) Facility Water Management Planning Guidelines.

2.0 FACILITY DESCRIPTION

EPA's NVFEL facility is located in Ann Arbor, Michigan. The 186,911 square foot building was constructed in 1970 to house offices, testing laboratories, and support spaces. The laboratory and support spaces occupy a high-bay building subdivided into 20 individual test cells, four soak zones where vehicles are maintained at constant temperature conditions, and support and preparation areas. Offices occupy the three wings off the high-bay building. The facility is owned and operated by EPA.

Some NVFEL staff occupy a leased office building adjacent to the laboratory. This plan does not address any aspects of the leased office building; it focuses on water management at the laboratory facility owned and operated by EPA.

NVFEL is part of the Office of Transportation and Air Quality (OTAQ) which is responsible for carrying out laws to control air pollution from motor vehicles, engines, and their fuels. OTAQ's mission is to reconcile the transportation sector with the environment by advancing clean fuels and technology, and promoting more livable communities. NVFEL's primary responsibilities include:

- Developing national regulatory programs to reduce mobile source related air pollution from light-duty cars and trucks, heavy-duty trucks and buses, nonroad engines and vehicles, and their fuels.

- Evaluating emission control technology.

- Providing state and local air quality regulators and transportation planners with access to critical information on transportation programs and incentive-based programs.

- Testing vehicles, engines and fuels.

- Determining compliance with federal emissions and fuel economy standards.

EPA awarded its first energy savings performance contract (ESPC) to NORESCO in 1998 for a comprehensive upgrade to the energy systems at NVFEL. This project has completely replaced the building's heating and cooling infrastructure, significantly reduced energy and water consumption, and lowered facility maintenance and utility costs. Key components of the ESPC included replacing 36 rooftop air handling units, replacing existing equipment in the central heating and cooling plant with one 440-ton and one 575-ton direct fired chiller-heater absorbers, one 30-ton capacity high efficiency condensing boiler, two 600-ton cooling tower cells with variable frequency fan drives, and a new pumping system. The upgraded chilled water system was sized to replace previous use of single pass-through cooling water with recirculated chilled water.

As part of a five year Master Plan, NVFEL will be adding three additions and will be conducting a build out and replacement of the vehicle fueling system. In addition, NVFEL will be installing a four wheel drive electric dynamometer. NVFEL also plans to install a new air handler, chiller, and cooling tower to handle the increased system demands. These systems are currently in the design phase.

3.0 FACILITY WATER MANAGEMENT GOALS

The resource conservation goals of NVFEL are achieved through the implementation of an Environmental Management System (EMS). NVFEL's Safety, Health, and Environmental Management Policy (June 2009) and draft fiscal year (FY) 2009 water conservation goals, as written by the facility, are provided below:

Safety, Health, and Environmental Management Policy

The NVFEL is committed to giving our employees and others on our site a safe environment. The health and welfare people who work at NVFEL is our top priority, and is an integral part of our mission to protect the environment and serve the American public. We use a Safety and Health Management System (SHMS) to organize the safety and health aspects of our Safety, Health, and Environmental Management program (SHEMP). Further, we use an Environmental Management System (EMS) to organize the environmental aspects of our SHEMP program. We seek to implement the goals championed in both of these systems and to monitor the progress towards attaining these goals. Our management systems are designed to ensure the integrity of our commitment through the following principles:

Compliance

We will meet and exceed regulatory compliance standards and comply with other requirements to which NVFEL subscribes, that relate to our safety, health and environmental aspects. To achieve our goal of meeting and exceeding compliance, we will promote safety, health and environmental awareness among our employees through training, and expect every employee to take responsibility for fulfilling our objectives. Further, we will inform our vendors, suppliers, and contractors of our safety, health and environmental requirements, and encourage them to comply with similar policies at their facilities.

Prevention

We are committed to providing safe and healthy working conditions and to assuring activities are managed to keep NVFEL free from recognized safety, health and environmental hazards. This commitment to the prevention of injury and ill health of our employees rather than reaction is the foundation of our SHEMP strategy. Unsafe acts or conditions must be promptly reported to the proper level of management for correction.

We will foster the sustainable use of our local natural resources by preventing pollution, reducing waste, and recycling. Whenever possible, we will do so by reducing waste at the source and using environmentally friendly products. We will insist on safe operating procedures, intelligent recycling/disposal of waste, and we will be fully prepared for emergencies that threaten these standard operating procedures.

Leading By Example

We are EPA, and we will set the example for others to follow. Employee involvement and participation is critical to our success. We will demonstrate our commitment to our Safety, Health and Environmental Management policies, and will share our success stories with others. As a community member and leader, we will strive to teach by doing - our work will be a model for others, and we will share our experience.

Continual Improvement

We will seize opportunities to go beyond defined requirements, to continually improve the SHEMP, and adapt to changing situations and emerging concerns. We will lead by example, self-correct, and share our lessons with others.

Environmental Management System Aspects, Objectives and Targets

In view of this Safety, Health, and Environmental Management Policy, NVFEL has reviewed its water consumption. In FY 2009, NVFEL identified water consumption as a significant environmental aspect. Through the February 24, 2010, Consumption of Natural Resources Environmental Management Program (EMP), NVFEL established an objective to reduce water consumption.

To meet this objective, NVFEL established the following specific targets:

- Reduce potable water intensity by 2 percent year over year.
- Reduce industrial water intensity by 2 percent year over year.
- Maintain water conservation efforts for landscaping and use no water for irrigation.

EO 13423 and 13514 Goals and ConservW Targets

NVFEL strives to achieve the water use intensity reduction goal set forth in EO 13514. Therefore, NVFEL has set a goal of reducing its water use intensity (in gallons per gross square foot [gal/GSF]) by 2 percent per year from an FY 2007 baseline through FY 2020, for a total reduction in water use intensity of 26 percent. NVFEL's FY 2007 baseline is 35.39 gal/GSF.

To continue progress toward meeting EO requirements, NVFEL will strive to meet annual facility-specific goals set by EPA's Sustainable Facilities Practices Branch under its ConservW program. These ConservW goals are calculated for each EPA facility based on the facility's previous water use reduction and its potential identified projects.

4.0 UTILITY INFORMATION

Contact Information

Potable water is provided by:

City of Ann Arbor Water Utilities
220 E Huron St, Suite 100
PO Box 8674
Ann Arbor, MI 48107-8647
(734) 994-2666

Sewer Service is provided by:

City of Ann Arbor Water Utilities
220 E Huron St, Suite 100
PO Box 8674
Ann Arbor, MI 48107-8647
(734) 994-2666

Table 1. NVFEL Water and Sewer Rate Schedule

Rate Fee	Charge	Unit
Water billing rate	$2.60	Per 100 cubic feet
Sewer billing rate	$3.10	Per 100 cubic feet
Domestic customer charge for water	$204.33	Per month
Domestic customer charge for sewer	$176.00	Per month
Stormwater discharge	$945.06 ($104.89/acre for 9.01 acres)	Per month
Fire service	$27.33	Per month

Payment Office

U.S. EPA - NVFEL
Attn: Account Operations
26 West M L K Drive
Cincinnati, OH 45268
513-487-2063

5.0 FACILITY WATER USE INFORMATION

The predominant feature of the NVFEL laboratory is the high-bay research space, where vehicles and engines are subjected to a variety of performance tests in individual test cells and soak zones. Engines tested vary in size, ranging from string trimmers to over the road diesel engines. Central plant utilities account for about 80 percent of total facility water use, the vast majority of which is for cooling tower make-up. In 2005 NVFEL also installed a water softener and reverse osmosis (RO) system to treat water used for humidification.

Since 2007, the facility has eliminated other significant uses of water including water used for braking power in most of the test dynamometers and water used for wet scrubbing of engine exhaust from the diesel engine test cells, and it has significantly reduced water used for sanitary purposes. The facility is not equipped with an irrigation system; therefore, virtually no water is used for landscape irrigation.

Major Water Using Processes

Estimated water use in FY 2009 by major process is shown in Table 2. The metered estimates are based upon water use data collected from 2001 through 2006 and meter readings obtained during a water assessment in March 2010.

Table 2. Major Water Using Processes, NVFEL

Major Process	FY 2009 Annual Consumption (gallons)	Percent of Total Water Use	Comments
Cooling tower make-up	3,550,000	77.9	Estimate based on metered data
Chilled water loop make-up	3,710	0.1	Estimate based on metered data
Hot water loop make-up	5,250	0.1	Estimate based on metered data
RO system concentrate (water used for humidification)	75,500	1.7	Engineering estimate based on metered data and instantaneous flow meter reading
RO system permeate	40,300	0.9	Engineering estimate based on metered data and instantaneous flow meter reading
Sanitary	500,000	11.0	Engineering estimate
Other miscellaneous water use	380,129	8.3	By difference
TOTAL	**4,554,889**	**100.0**	**Metered**

Additional details on assumptions and calculations supporting these water use estimates are provided in Appendix A. Monthly total water use in FY 2009 is provided in Appendix B.

Measurement Devices

Incoming city water supply is metered. Flow totalizing meters are also installed on many of the subsystem flows in the central utility plant, including cooling tower make-up water, chilled water loop make-up, hot water loop make-up, water used for humidification, and domestic hot water. Flow totalizer readings are recorded daily in the utility plant operator's notebook.

Under this plan flow data from all meters will be reported at least monthly to the facility manager and water use trends will be monitored on an ongoing basis. Unexpected changes in water use will be investigated and resolved.

Shut-off Valves

A 6-inch city supply line shutoff is located west of Equipment Room 522 in the berm of the city easement, and the building shutoff is located inside the building on the north wall of Room 522.

Occupancy and Operating Schedules

Approximately 250 employees work at NVFEL. The laboratory operates on a flex time schedule and is typically occupied between 5 a.m. and 6 p.m., Monday through Friday. Occasionally some staff may work over night and on the weekends.

6.0 BEST MANAGEMENT PRACTICE SUMMARY AND STATUS

EO 13423, *Strengthening Federal Environmental, Energy, and Transportation Management*, signed in January 2007, calls for federal agencies to reduce water use intensity by 2 percent per year between FY 2007 and FY 2015, for a total reduction of 16 percent. This goal was extended by EO 13514, *Federal Leadership in Environmental, Energy, and Economic Performance*, signed in October 2009. EO 13514 calls for reducing potable water consumption intensity by 2 percent annually through the end of FY 2020, for a total reduction of 26 percent. Facilities should implement best management practices (BMPs) related to water use, considering life-cycle cost effectiveness, to achieve this water reduction goal. FEMP has identified BMPs in 14 areas to help facilities identify and target water use reductions. NVFEL has adopted BMPs in 10 of the areas, designated by checkmarks in the list below. One other area is deemed inapplicable for NVFEL, as designated by "NA" in the list below. The status of each BMP at NVFEL is as follows:

- ☑ Water Management Planning
- ☑ Information and Education Programs
- ☑ Distribution System Audits, Leak Detection and Repair
- ☑ Water-Efficient Landscaping
- ☑ Water-Efficient Irrigation
- ☑ Toilets and Urinals
- ☑ Faucets and Showerheads
- ☑ Boiler/Steam Systems
- ☑ Single-Pass Cooling Equipment

☐ Cooling Tower Management
NA Commercial Kitchen Equipment
☑ Laboratory/Medical Equipment
☐ Other Water Use
☐ Alternate Water Sources

Information and Education Programs

Employees are educated on water conservation topics through the implementation of the EMS. In particular, employees are trained to use the recirculating chilled water loop, rather than single pass city water, as a source of cooling water. In addition, all group managers participated in a careful examination of facility water use as part of the ESPC planning process. NVFEL holds monthly meetings with janitorial staff and conducts outreach to its employees through an email distribution list to let them know that certain projects have been completed. NVFEL is considering developing a quarterly news release to highlight accomplishments and further raise awareness. NVFEL also promotes water and energy conservation and awareness using the FEMP *Lead by Example* poster series. Conservation posters are displayed in prominent locations throughout the building. NVFEL has shared its accomplishments at the annual EPA Buildings and Facilities Conference. BMP status is achieved in this area.

Distribution System Audits, Leak Detection and Repair

A screening level system audit was conducted in March 2010, and known water uses account for greater than 90 percent of water consumption.

Facility staff are trained to report leaks and malfunctioning water-using equipment to a facility maintenance help line. Reported problems are assigned a work order, which is completed by the facility operation and maintenance contractor. In addition, the facility operation and maintenance (O&M) contractor performs a daily inspection of all sanitary fixtures to maintain and ensure proper operation.

BMP status is achieved in this area.

Water-Efficient Landscape

Grasses and shrubs are climate appropriate and survive on natural rainfall. BMP status has been achieved in this area.

Water-Efficiency Irrigation

No landscape irrigation water is used at NVFEL. BMP status has been achieved in this area.

Toilets and Urinals

All restrooms nave been renovated to include high-efficiency fixtures (1.28 gallons per flush [gpf] toilets and 1 pint per flush urinals). As a preventative maintenance measure, all flush valves in toilets and urinals are replaced once per year.

Janitorial staff and employees are trained to report leaks or other maintenance problems, which are immediately corrected. In addition, the facility operation and maintenance contractor performs a daily inspection of all sanitary fixtures to maintain and ensure proper operation.

BMP status is achieved in this area.

Faucets and Showerheads

High-efficiency lavatory faucets (0.5 gallons per minute [gpm]) with automatic sensors have been installed throughout the facility. Energy Policy Act of 1992 (EPAct 1992)-compliant shower heads (2.5 gpm) are installed in the shower room. System pressure is maintained between 20 to 80 pounds per square inch (psi).

Janitorial staff and employees are trained to report leaks or other maintenance problems, which are immediately corrected. In addition, the facility operation and maintenance contractor performs a daily inspection of all sanitary fixtures to maintain and ensure proper operation.

BMP status is achieved in this area.

Boiler/Steam Systems

Prior to the ESPC, three 700-horsepower boilers produced steam at 100 psi, which was distributed to the facility at 35 psi via a pipe loop. Boiler make-up water accounted for approximately 1,000,000 gallons per year of facility water. This system was replaced with high-efficiency condensing boilers, and a new hot water piping distribution system was installed. This heating plant upgrade eliminated steam condensate blowdown and significantly reduced make-up water demand. Hot water loop make-up now accounts for only 5,250 gallons per year of facility water consumption.

BMP status is achieved in this area.

Single Pass Cooling Equipment

Prior to the ESPC, single pass cooling water was used to cool the building air compressors and process chillers and to remove the heat load from engines being tested. These uses accounted for approximately 23,000,000 gallons per year in water consumption. As part of the ESPC, an upgraded cooling plant was installed which included a recirculated chilled water loop designed to provide cooling for all these applications. Recirculated chilled water is now used for cooling the air compressors and process chillers. Recirculated chilled water is also available in each engine test cell, and all have been converted to using the chilled water system and heat exchangers for engine cooling. In emergencies, NVFEL may use water-cooled air compressors; however these compressors are being replaced with rotary units, and the use of single-pass cooling will be eliminated after this switch.

BMP status is achieved in this area.

Cooling Tower Management

A new cooling tower system was installed under the ESPC, consisting of two 600-ton capacity cooling tower cells with variable frequency fan drives, new pumping systems, and associated controls. The cooling tower system is equipped with an ozone treatment system to reduce biological growth and a side stream sand filtration system to reduce solids build-up and enable a higher degree of cooling water recycle. Cooling tower make-up water use is metered and the flow is recorded daily. NVFEL is considering adding an additional meter to the blowdown line in order to obtain credit on sewer charges for water that is lost due to evaporation.

Tower blowdown is controlled based on water conductivity; the conductivity target for the system is 1800 microSiemens per centimeter (*u*S/cm). This conductivity control point provides for approximately four cycles of concentration and efficient cooling tower water use. NVFEL is in the process of replacing its liquid chemical feed system with dry chemicals, which is intended to increase the efficiency of the cooling tower.

The cooling tower maintenance contractor has been informed that water conservation is an operational goal of the facility. The contractor routinely monitors the cooling system water quality for optimum performance.

BMP status in this area will be achieved pending the establishment of a process to record cooling tower make-up water use and cooling tower water chemistry, monitor trends in water consumption, and investigate and resolve unexpected changes in water use.

Commercial Kitchen Equipment

NVFEL does not operate commercial kitchen equipment. BMP status is not applicable in this area.

Laboratory/Medical Equipment

Process water is used at NVFEL to place a resistance load on chassis test dynamometers. NVFEL has replaced all but one of these dynamometers with dynamometers that use electric resistance rather than water resistance.

NVFEL has eliminated water used for wet scrubbing of engine exhaust from the diesel engine test cells.

BMP status is achieved in this area.

Other Water Use

NVFEL installed a water softener and RO system in 2005 to pre-treat water used for humidification. The RO system is equipped with a level controller so that the system only operates on demand. The capacity of the RO system is 5,000 gallons per day. When operational, the system discharges approximately 1.9 gallons of concentrate per gallon of permeate, totaling approximately 75,500 gallons per year. NVFEL is considering routing the RO concentrate to the cooling tower sump for use in cooling tower water make up. NVFEL's cooling tower maintenance contractor assesses the Ryznar Stability Index of the RO system periodically to

ensure that the system is operating within the appropriate limits to minimize scaling tendencies. The water softener is demand-based and backwashes as necessary.

BMP status will be achieved in this area once RO concentrate is routed to cooling tower for use as make-up water.

Alternate Water Use

NVFEL is considering a project to collect air handler condensate from two roof top air handling units to use as cooling tower make up water. BMP status can be achieved in this area if this project is implemented.

7.0 DROUGHT CONTINGENCY PLAN

Water shortages are uncommon in Ann Arbor due to an abundant water supply. The City of Ann Arbor does not have an official water management plan specifically for droughts, but it does have a general emergency action plan, which may be implemented if a drought occurs. Historically, the only action that has been taken during previous droughts has been the restriction of landscape watering. NVFEL does not use any water for landscape irrigation.

In the event that voluntary or mandatory water consumption reductions are instituted by Michigan Department of Natural Resources or City of Ann Arbor Water Utilities, NVFEL will form a task force of facility and operating personnel to identify and implement modifications to facility operations to achieve additional specified reductions in water consumption.

8.0 COMPREHENSIVE PLANNING

Under the existing NVFEL Policy for Approval of Facility Changes and Modifications, any material changes to the NVFEL facility require participation and review by the Central Services Group Manager during the planning process, including sign-off by the Central Services Group Manager before the project is approved for implementation. As part of this review, the Central Services Group Manager will ensure that water efficiency BMPs are taken into account during the initial stages of planning and design for any facility modifications, renovations or new construction. Water efficiency BMPs will also be considered prior to the purchase and installation of any equipment that would measurably change facility water consumption.

9.0 STATUS UNDER GUIDING PRINCIPLES FOR HIGH PERFORMANCE AND SUSTAINABLE BUILDINGS

The Interagency Sustainability Working Group (ISWG), formed as a subcommittee of the EO 13423 Steering Committee, has established guiding principles to assist agencies in meeting the high performance and sustainable buildings goals of EO 13423, section 2(f). The December 1, 2008, version of the ISWG's *Guiding Principles for Sustainable Existing Buildings* established six supporting principles for protecting and conserving water. NVFEL's status toward achieving the supporting principles for protecting and conserving water at existing buildings is documented in Table 3.

Table 3. Status of Guiding Principle to Protect and Conserve Water

Topic	Status
Indoor Water	NVFEL's potable water use is approximately 27.6 percent less than the water use baseline, established as 120 percent of the Uniform Plumbing Code. NVFEL has performed multiple water conservation projects since 2003, including upgrading to high-efficiency sanitary fixtures. The Natural Resources Consumption EMP contains an objective to reduce water use by 2 percent per year.
Outdoor Water	Grasses and shrubs are climate appropriate and survive on natural rainfall. No landscape irrigation water is used at NVFEL.
Water Metering	Incoming city water supply is metered. Flow totalizing meters are also installed on many of the subsystem flows in the central utility plant, including cooling tower make-up water, chilled water loop make-up, hot water loop make-up, water used for humidification, and domestic hot water, though they have not been read since 2006. Under EPA's National Advanced Metering System, water utility meters will be tied into the advanced metering system.
Stormwater Management	Seventy-five percent of NVFEL's stormwater flows in underground piping to a stormwater detention pond that is not owned by EPA, and the rest flows into combined sewers. NVFEL considered permeable/porous pavement for ongoing asphalting projects, but decided against it because the soil's clay content may prevent drainage. NVFEL also considered a green roof but could not secure funding for the project. Stormwater ponding is a major issue on the NVFEL grounds, and the facility is actively looking for projects to improve site drainage. The facility manager noted that the opportunity for roof water capture exists, but a project to collect roof water has not been programmed or funded. NVFEL does not have a stormwater management plan.
Process Water	NVFEL does not use potable water to improve its energy efficiency at the expense of water efficiency.
Water-Efficient Products	Purchasing procedures do not specify the purchase of water-efficient products. Acquisition personnel are trained on the procurement of WaterSense® labeled and water-efficient products. Toilets, urinals, and faucets were upgraded in FY 2008 and FY 2009 to maximize water efficiency. The facility manager and procurement staff review all purchases for sustainability; however, the process and review procedure are not documented.

10.0 OPPORTUNITIES FOR FURTHER WATER CONSERVATION

NVFEL is pursuing the following projects to achieve additional reductions in water use:

1) **Route RO Concentrate to Cooling Tower Sump for Make-Up.** Currently the RO concentrate (approximately 1.9 gallons for every gallon of RO permeate) is discharged to the sewer. NVFEL will route the RO concentrate to the cooling tower sump to serve as make-up water for the cooling tower. NVFEL will also install a meter on the RO concentrate line and will report this metered data to the City in order to receive a discount for the discharge of this water that is no longer being sent to the sewer. This project is expected to save approximately 75,500 gallons and $570 per year. At a cost of approximately $2,000 to install the water meter and run the piping from the RO system to the cooling tower sump, this project's payback period is expected to be 3.5 years.

2) **Capture and Reuse Air Handler Condensate.** NVFEL will evaluate capturing air handler condensate from air handlers 25 and 48 and routing it to the cooling tower. These two air handling units supply 100 percent outside air to the cooling zones they service and are located in close proximity to the cooling tower, so collecting air handler condensate from these two units is most feasible and cost-effective. Initial engineering evaluation indicates that it may be possible to capture up to 100,000 gallons of condensate per year from these air handlers. This water will offset the consumption of potable water for cooling tower make-up and result in savings of approximately $750 per year. This project is estimated to cost $10,000 and result in a payback of approximately 13 years.

3) **Meter Cooling Tower Blow Down**. NVFEL is considering metering the blow down water line from the cooling tower. This data will be used to determine how much water is lost due to evaporation from the cooling tower. NVFEL will report the evaporated water loss to the city in order to receive a discount for the discharge of this water that is not being sent to the sewer. This project is expected to save approximately $11,000 per year in sewer charges. At a cost of approximately $500 for the water meter, this project's payback period is expected to be well under one year.

4) **Record, Monitor, and Evaluate Changes in Water Consumption.** Water use is currently metered for the cooling tower make-up water, chilled water loop make-up, hot water loop make-up, water used for humidification, and domestic hot water. NVFEL will ensure that these meters are read and the water consumption recorded daily. Monthly, NVFEL will evaluate the water use data to monitor trends in water consumption and investigate and resolve unexpected changes. As additional meters are added, these will also be recorded and monitored. This project has no additional associated capital cost and will help ensure that existing systems are operated in the most efficient manner possible.

5) **Track Cooling Tower Water Chemistry.** The cooling tower maintenance contractor routinely monitors the cooling system water quality for optimum performance. NVFEL will review the cooling tower water chemistry reports monthly to ensure that the cooling tower is operating at its maximum efficiency and will work with the cooling tower maintenance contractor to investigate and resolve any unexpected changes. This project has no additional associated cost.

Appendix A

WATER BALANCE SUPPORTING CALCULATIONS

Table A-1. Water Balance Supporting Calculations – FY 2009, National Vehicle and Fuel Emissions Laboratory, Ann Arbor, Michigan

Major Process	FY 2009 Annual Consumption (gallons)	Comments
Cooling tower make-up	3,550,000	Estimate, based on metered data from March 2006 and March 2010. March 6, 2006, meter reading: 27,436,600. March 4, 2010, meter reading: 41,639,000. Annual average water use: (41,639,000 gallons – 27,436,600 gallons) / 4 years = 3,550,600 gallons/year.
Chilled water loop make-up	3,710	Estimate, based on metered data from May 2006 and March 2010. May 17, 2006, meter reading: 160. March 4, 2010, meter reading: 14,380. Annual average water use: ((14,380 gallons – 160 gallons) / 46 months) * 12 months/year = 3,710 gallons/year.
Hot water loop make-up	5,250	Estimate, based on metered data from March 2006 and March 2010. March 6, 2006, meter reading: 71,800. March 4, 2010, meter reading: 92,800. Annual average water use: (92,800 gallons – 71,800 gallons) / 4 years = 5,250 gallons/year.
RO system concentrate (water used for humidification)	75,500	RO system input (humidification water) is estimated based upon metered data from March 2006 and March 2010. March 6, 2006 meter reading: 526,336. March 4, 2010 meter reading: 989,680. Annual average water use: (989,680 gallons - 526,336 gallons)/4 years = 115,836 gallons/year. RO system concentrate is based upon engineering estimate from instantaneous flow meter reading; 5.6 gallons of permeate per 10.5 gallons of concentrate (0.53 gallons permeate/gallon concentrate). RO system input = X gallons concentrate + X gallons permeate, and gallons permeate = 0.53 gallons concentrate. Assuming an RO system input of 115,836 gallons, the amount of RO concentrate is: 115,836 gallons/year = (X * 0.53 gallons concentrate + X gallon concentrate); X = 75,545 gallons concentrate/year.
RO system permeate	40,300	Estimated as the difference between RO system input minus RO system concentrate: 115,836 gallons/year – 75,545 gallons/year = 40,291 gallons/year.
Sanitary	500,000	Engineering estimate based on 250 people using 8 gallons/day, 250 days per year: 8 gallons/person/day * 250 people * 250 days/year = 500,000 gallons/year. This estimate includes 110,000 gallons of domestic hot water, which is metered.
Other miscellaneous water use	380,129	Engineering estimate, by difference: total metered city water use minus all other calculated city water uses: (4,554,889 gallons – 3,550,000 gallons – 3,710 gallons – 5,250 gallons – 116,000 gallons – 75,500 gallons – 500,000 gallons = 304,429 gallons.
TOTAL	**4,554,889**	**FY 2009 total reported water use.**

Appendix B

MONTHLY WATER USE IN FY 2009

Table B-1. Monthly Water Use in FY 2009, NVFEL, Ann Arbor, Michigan

Month Year	Consumption (100 Cubic Feet)	Consumption (Gallons)
October 2008	451.0	337,371
November 2008	283.0	211,699
December 2008	177.0	132,405
January 2009	297.0a	222,171
February 2009	234.0	175,044
March 2009	328.0	245,361
April 2009	501.0	374,774
May 2009	521.0	389,735
June 2009	739.0	552,810
July 2009	757.0	566,275
August 2009	1,033.0	772,738
September 2009	768.0	574,504
Total water use	6,089	4,554,889

a – Water meter reported wiring errors during an audit, giving faulty readings. The meter was replaced in the beginning of February and is now reading correctly. January's invoice shows the adjustment and credit to the account (overbilled by $20,000), but does not accurately display January's consumption. January's consumption is not available from the facility or utility company. The January FY 2008 consumption figure has been used as a proxy.

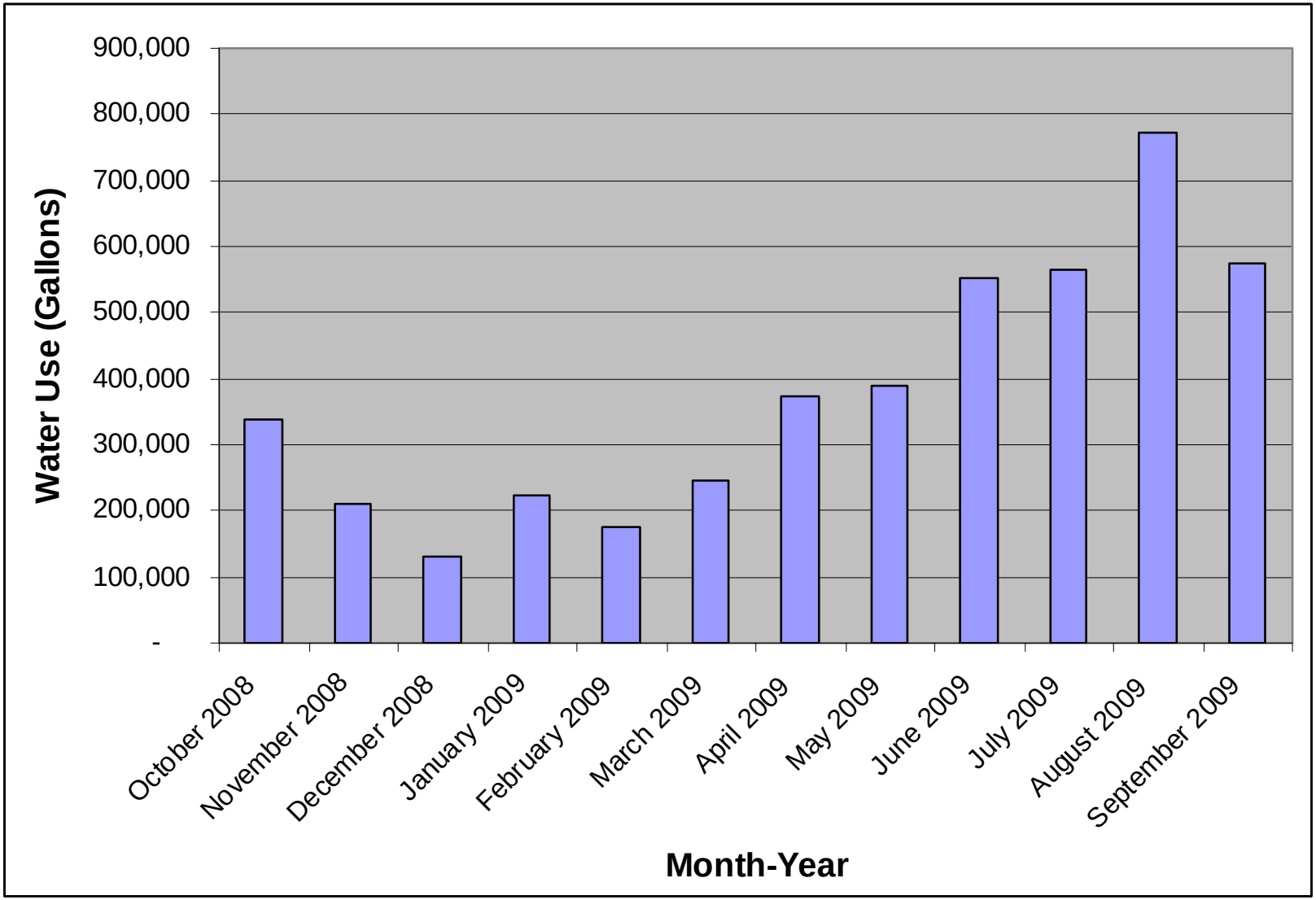

Figure B-1. Monthly Water Use in FY 2009, NVFEL, Ann Arbor, Michigan